JOHN FLUKE MFG. CO., INC.
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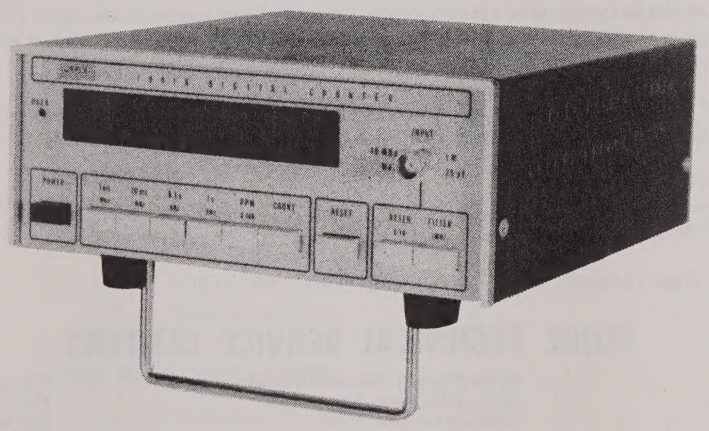

MODEL

1941A

DIGITAL COUNTER

PRELIMINARY MANUAL

WARRANTY

The JOHN FLUKE MFG. CO., INC.* warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the orginal purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operations, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

1. Notify the John Fluke Mfg. Co., Inc.,* giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

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CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc.* Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc.* will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to: JOHN FLUKE MFG. CO., INC., P.O. BOX 7428, SEATTLE, WASHINGTON 98133.*

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Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 1941A Digital Counter is a rugged, high speed counter designed for industrial and general purpose use. All counter functions and ranges are controlled by easy to use pushbuttons. The six digit neon tube display makes reading the value of input frequencies easy, even at distances up to twenty feet.

1-3. The 1941A will accurately measure inputs of 5 Hz to 40 MHz, with an input sensitivity of 40 mV. In the totalize mode the counter will count and display all inputs up to 999,999 cycles. It also has an RPM mode that will display the speed of a one pulse per revolution generator, in hundreds of RPM's. A selectable low pass filter and X10 attenuator permit operation of the counter in electrically noisy environments. The front panel RESET button is provided to clear the display and initiate a new measure cycle.

1-4. Optionally available features include a BCD output that provides for external uses of the counter display. A "print" signal insures that the BCD frequency count is complete before the information is used externally. A TTL-compatable, BCD preset input option, allows the 1941A display to be set so the input frequency and the offset, when added together, form an easily read number. This feature could eliminate errors caused by misread complex numbers. To make the BCD offset feature even more versatile the A41 External Offset Control Unit is offered as an accessory. This unit allows the BCD offset to be easily changed to suit the requirements of the application.

1-5. SPECIFICATIONS

FREQUENCY RANGE	5 Hz to 40 MHz (filter out) 5 Hz to 1 MHz (filter in)
INPUT SENSITIVITY:	
Sine Wave	40 mV rms (attenuator out) 400 mV rms (attenuator in)
Pulse	150 mV p-p (attenuator out) at minimum pulse width of 15 nsec 1.5V p-p (attenuator in)

INPUT IMPEDANCE	1MΩ shunted with less than 20 pF (with filter out)
OVERLOAD CAPABILITY	150V rms for frequencies up to 1 kHz, decreasing to 5V rms (attenuator out), or 50V rms (attenuator in) at 40 MHz. DC + peak ac not to exceed 250V.
GATE TIMES	1 msec, 10 msec, 100 msec, and 1 sec (RPM gate time 600 ms)
TOTALIZING	Counts to 999999, then activates overflow indicator
READOUT	6 digit in-line display incorporating long-life gas-discharge tubes. LED overflow indicator.
DISPLAY TIME	200 msec plus gate time
TIME BASE:	
Aging Rate	6×10^{-7}/day, 2×10^{-6}/month
Temperature Dependence	1×10^{-6} (20°C to 30°C) 5×10^{-6} (0°C to 40°C)
Line Voltage Dependence (±10% Change)	2×10^{-7}
EXTERNAL TIMEBASE INPUT	
Frequency	10 MHz
Sensitivity	500 mV rms
Impedance	20k shunted with 50 pF
OPTIONAL BCD OUTPUT AND BCD PRESET	4 line 8-4-2-1 preset to each digit TTL compatible, high true. Fanout is 8 54/74 loads.
STORAGE TEMPERATURE RANGE	−40°C to +75°C
OPERATING TEMPERATURE RANGE	0°C to +40°C
POWER REQUIREMENTS	115V rms ±10% or 230V rms ±10% (switchable) 50 – 60 Hz (100V available upon request), 14 watts.
FUSE	1 Amp (115V) or ½Amp (230V)
DIMENSIONS	3" High – 7.6 cm 7½" Wide – 19.05 cm 9¼" Deep – 23.5 cm
WEIGHT	6 Pounds – 2.7 kg

INPUT IMPEDANCE	1MΩ shunted with less than 20 pF (with filter out)
OVERLOAD CAPABILITY	150V rms for frequencies up to 1 kHz, decreasing to 5V rms (attenuator out), or 50V rms (attenuator in) at 40 MHz. DC + peak ac not to exceed 250V.
GATE TIMES	1 msec, 10 msec, 100 msec, and 1 sec (RPM gate time 600 ms)
TOTALIZING	Counts to 999999, then activates overflow indicator
READOUT	6 digit in-line display incorporating long-life gas-discharge tubes. LED overflow indicator.
DISPLAY TIME	200 msec plus gate time
TIME BASE:	
Aging Rate	6×10^{-7}/day, 2×10^{-6}/month
Temperature Dependence	1×10^{-6} (20°C to 30°C) 5×10^{-6} (0°C to 40°C)
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EXTERNAL TIMEBASE INPUT	
Frequency	10 MHz
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Impedance	20k shunted with 50 pF
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STORAGE TEMPERATURE RANGE	–40°C to +75°C
OPERATING TEMPERATURE RANGE	0°C to +40°C
POWER REQUIREMENTS	115V rms ±10% or 230V rms ±10% (switchable) 50 – 60 Hz (100V available upon request), 14 watts.
FUSE	1 Amp (115V) or ½Amp (230V)
DIMENSIONS	3" High – 7.6 cm 7½" Wide – 19.05 cm 9¼" Deep – 23.5 cm
WEIGHT	6 Pounds – 2.7 kg

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section contains operating instructions for the proper use of the Model 1941A Digital Counter. It is recommended that the contents of this section be thoroughly read and understood before any attempt is made to operate this instrument. Should any difficulties be encountered, please contact your nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc., P.O. Box 7428, Seattle, Washington 98133, Telephone (206) 774-2211. A list of Sales Representatives is located at the rear of this manual.

2-3. SHIPPING INFORMATION

2-4. The Model 1941A was packaged and shipped in a foam packed cardboard carton. After unpacking the unit a thorough inspection should be performed to reveal any damage that may have occurred in transit.

2-5. If reshipment is necessary, the 1941A should be repackaged in the original container. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the Model number (Model 1941A) when requesting a new shipping container.

2-6. INPUT POWER REQUIREMENTS

2-7. This frequency counter may be operated from either 105 to 125V rms or 210 to 250V rms, 50 to 60 Hz line power. A side switch, located at the rear of the unit, selects either the 115 or 230 volt line power requirement.

2-8. OPERATING NOTES

2-9. Front Panel Control and Indicator Location and Function

2-10. The location, by reference number, of the front panel controls and indicators is shown in Table 2-1. The name and function of each control or indicator is listed by reference number.

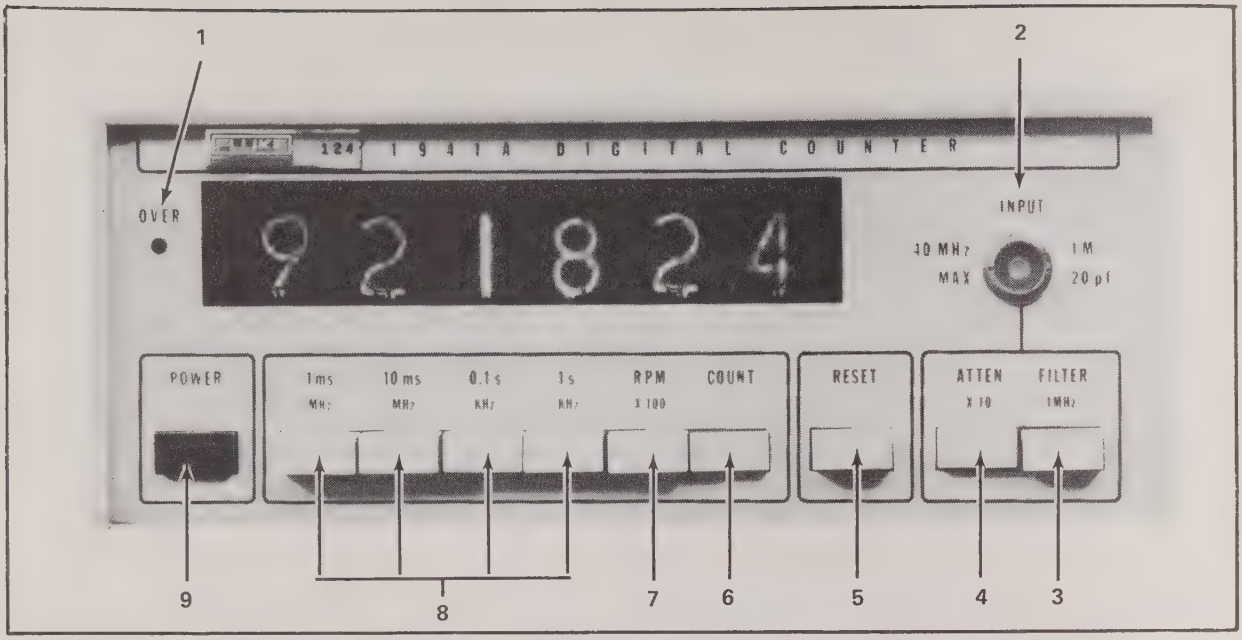

Table 2-1. FRONT PANEL CONTROL AND INDICATOR FUNCTIONS

REF. NO.	NAME	FUNCTION
1	OVERflow Indicator	illuminates when the count of the input frequency has exceeded the display capacity.
2	INPUT Jack	is used for all frequency input to be counted by the 1941A.
3	FILTER	when depressed filters out input frequencies above 1 MHz.
4	ATTENuator X10	when depressed will attenuate the input signal by 10 times.
5	RESET	will reset the display to 000000.
6	COUNT	will continuously count and totalize the input cycles.
7	RPM X100	will display the speed of a one pulse per revolution devise in hundreds of RPM's
8	Range and Gate time Switches	selects the length of the counting time (1 sec., 0.1 sec., 10 ms, or 1 ms)
9	POWER	push in to turn the unit on.

2-11. Rear Panel Control and Connector Location and Function

2-12. The controls and connectors on the rear panel are shown in Table 2-2, each is identified by a reference number. The Table also gives the name of each reference numbers control or connector and the function it performs.

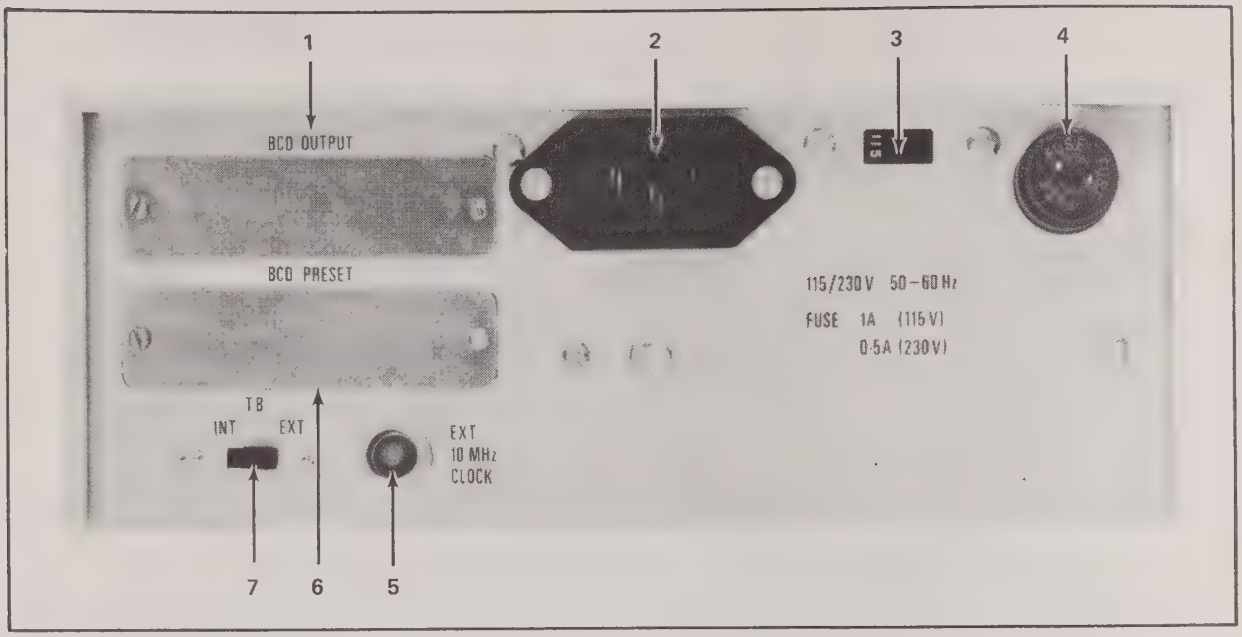

Table 2-2. REAR PANEL CONTROL AND CONNECTOR FUNCTIONS

REF. NO.	NAME	FUNCTION
1	BCD OUTPUT	when the –02 Option is installed the 1941A will provide a BCD output equivalent to the counter readout.
2	AC line power input	connects the AC 115V or 230V to the counter.
3	Power selection switch	selects either 115V or 230V power transformer configuration.
4	Line fuse	a 1A (115V) or 0.5A (230V) input power protection fuse.
5	EXTernal 10 MHz CLOCK	provides for the use of an external source for the time base frequency
6	BCD PRESET	the –05 Option, when installed, allows the counter display to be set to any predetermined display, from which the input frequency count will start.
7	Time Base INTernal EXTernal selection switch	selects for use as the time base, either the internal 10 MHz oscillator or the external input 10 MHz.

NOTE!

If the TB INT EXT switch is in the EXT position the counter will not properly operate in any function except COUNT, if an external 10 MHz CLOCK is not connected to the counter.

2-13. COUNT Function

2-14. The 1941A is able to display the total number of cycles of an input signal, that occur over any desired length of time. This feature can be used to count the number of cycles of a very low frequency signal or the pulses of an nonrepititous pulse train, over a long period of time. The control settings for this function are as follows:

a. Turn the 1941A on by depressing the POWER button.

b. Push the COUNT button.

c. Connect the signal to be counted to the INPUT jack.

d. The display should be reset to zero to insure a proper count of the input signal. This is done by depressing the RESET button.

2-15. RPM Function

2-16. The counter can be used as a techometer to digitally display the revolving speed of a one pulse per revolution transducer. The display readout is in hundreds of RPM's. When the RPM function is selected the counter gate time is set at 0.6 seconds, and the display will not have a decimal point indication. The RPM mode of operation is called by setting the controls as follows:

a. Turn the 1941A on by depressing the POWER button.

b. Push the RPM button.

c. Connect the transducer output to the counters INPUT jack.

2-17. Frequency Measurement

2-18. The 1941A counter is capable of digitally displaying frequency inputs within the range of 5 Hz to 40 MHz. The display is in either kHz (two ranges) or MHz (two ranges). The four range and gate time switches on the front panel control the decimal point location and range of the display. The counter can be set for time base controlled counting of input signals as follows:

a. Turn the 1941A on by depressing the POWER button.

b. Select the range for displaying the frequency of the input signal. The display capacity increases from 999.999 kHz in the 1s gate time to 040.000 Mhz in the 1ms gate time.

c. Connect the signal to be counted to the INPUT jack.

2-19. External 10 MHz Clock

2-20. An external 10 MHz oscillator can be substituted for the internal oscillator. The output of the external 10 MHz source must be connected to the EXT 10 MHz CLOCK input jack on the rear panel of the counter, and the TB INT-EXT switch in the EXT position.

Section 3
Theory of Operation

3.1 INTRODUCTION

3-2. This section of the manual contains the theory of operation for the Model 1941A Digital Frequency Counter. Frequency counter operation in general will be discussed first, with an introduction to the basic block diagram of the 1941A. The individual sections of the block diagram will then be presented in more detail in order to better understand the counter. It is recommended that this section be thoroughly read and understood before an attempt is made to service this instrument.

3-3. GENERAL INFORMATION

3-4. Generally, the frequency of a signal is measured by counting the number of complete cycles of the unknown signal that occur during a known time interval. A digital frequency counter is designed to "sample" the incoming waveform for a precisely controlled length of time and count the number of cycles during this time. The actual count is applied to a "count and display" section where a number of high-speed flip-flops connected in series, decimally count and display the input. A "program logic" section is required to control the repetitive requirements to reset the counters, open the sample gate, close the sample gate, update the display, and then reset the counters again. The timing of these events is usually controlled by the output of a stable crystal oscillator.

3-5. The theory of operation for the Model 1941A Digital Counter is presented in the following paragraphs. Figure 3-1 shows a basic block diagram of the 1941A. The functional purpose of the sections of the block diagram will be discuessed separately.

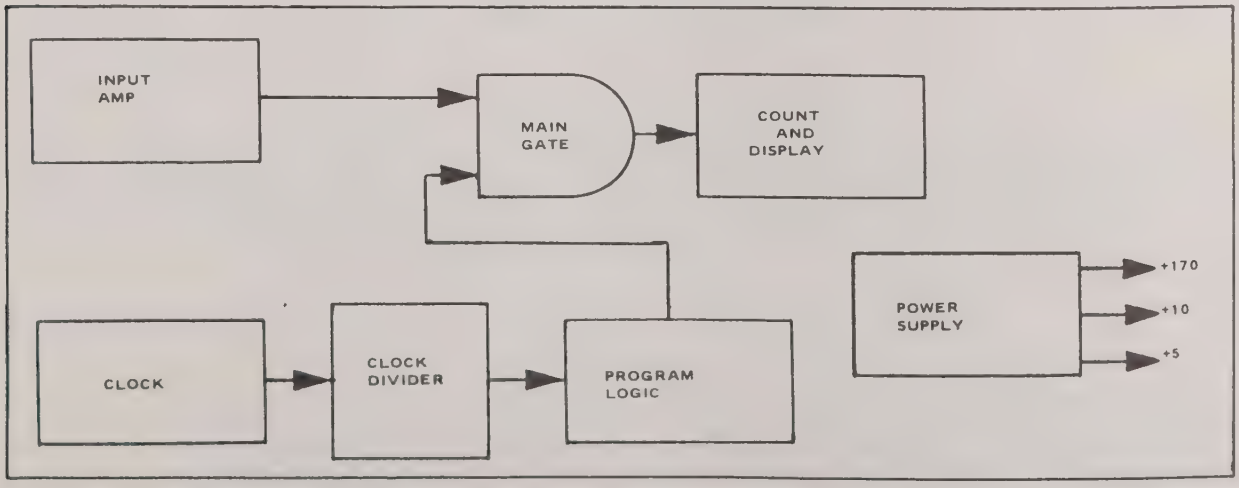

Figure 3-1. 1941A BLOCK DIAGRAM

3-6. CIRCUIT DESCRIPTION

3-7. Input Amplifier

3-8. The input signal is AC coupled to the X1/X10 attenuator switch, as shown in Figure 3-2. In the X10 position the level of the input signal is reduced 10 times. The input can be filtered to provide for more accurate low frequency readings by depressing the filter pushbutton. The filter limits the high end of the input frequency range to 1 MHz. An input buffer provides for broadband frequency coverage with high input impedance. The buffered input signal is amplified, then shaped into squarewaves by the schmitt trigger. The last stage of the input amplifier translates the schmitt trigger output into TTL form for use by the logic controlled Main Gate.

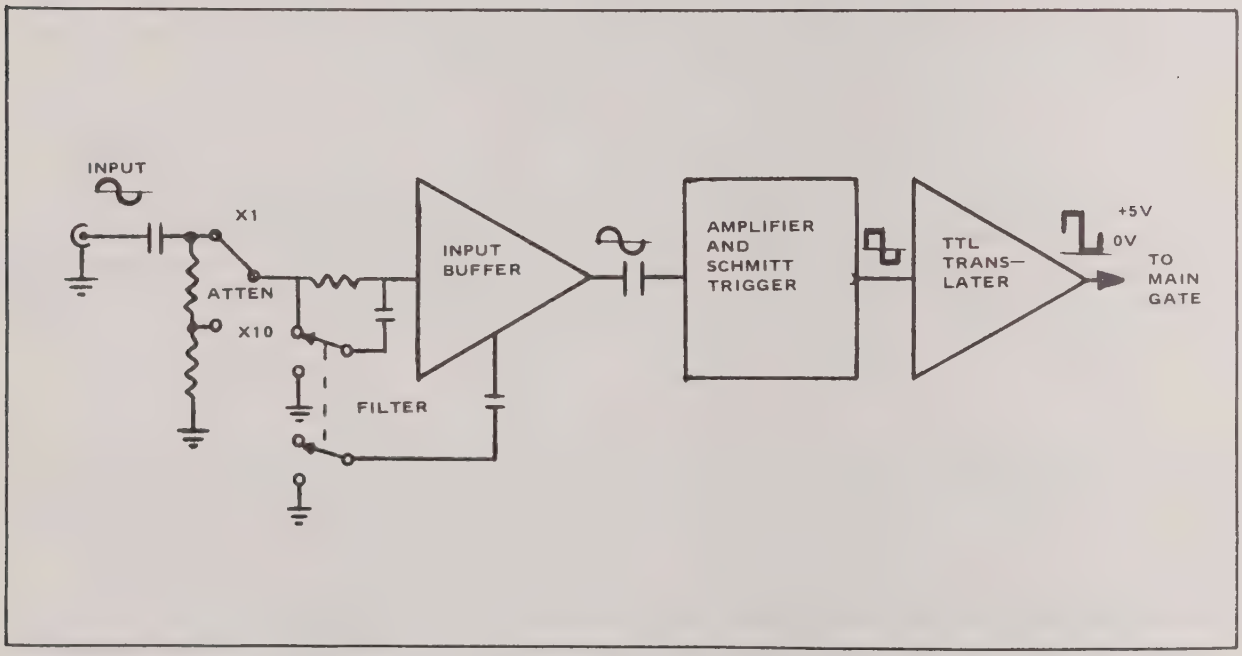

Figure 3-2. INPUT AMP

3-9. Main Gate

3-10. The input signal, in TTL form, is applied to one input of the Main Gate. Because this gate input signal is alternating between a TTL "1" and "0" at the rate of the counter input signal, anytime the other input of the gate is held at a logic "1" the output will change state at the same rate. The logic "1" that enables the Main Gate is supplied either continuously, when the Count button is selected or for precisely controlled time periods when a gate time or the RPM button is depressed.

3-11. Clock

3-12. The Clock supplies the stable frequency that will be used to time the events during the counter operation of measuring the frequency of an input signal. Figure 3-3 shows the basic configuration of the Clock and how the external clock input may be substituted for the internally generated clock. The clock signal is translated into a TTL compatable waveform before it is applied to the Clock Divider.

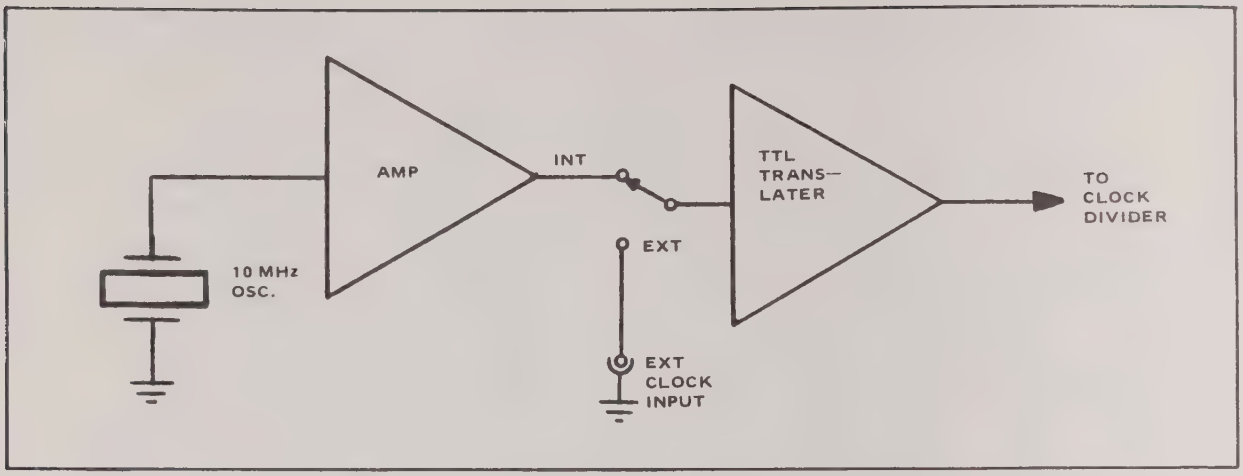

Figure 3-3. CLOCK

3-13. Clock Divider

3-14. The 10 MHz Clock output signal is applied to the input of the first of three series connected TTL high-speed decade counters. Each counter divides its input by ten, thus reducing the 10 MHz input signal to a 10 kHz output. In the 1ms – 1s gate times the 10 kHz signal is directly applied to the Program Logic. When the RPM button is selected the 10 kHz signal is divided by six, in a fourth high-speed counter, to produce the 1.666 kHz signal that is applied to the Program Logic.

3-15. Program Logic

3-16. The Program Logic receives the Clock Divider output signal and divides it, in four series connected decade counters to produce the 1ms – 1s gate time control signals. To start a frequency measurement cycle one of the four gate times or the RPM pushbutton must be selected. The 1ms gate time will be used in the following discussion.

3-17. Figure 3-4 shows the basic configuration of the Program Logic. The alphabetical identifications are for discussion purposes only. A measurement cycle starts at the end of the reset signal applied to the decade counters. The output of each counter drops to zero volts at that time. When the negative transition of the signal is felt at the clock input of the first flip-flop it will change state putting a +5 volts on the Q output. The +5 volts from the Q output not only enables the main gate to pass the 1941A input signal, it also disables the 4 line to 10 line counter. This is done to keep the update (M) and reset (R) signals disabled while the main gate is open.

3-18. As the Clock Divider output is counted by the first decade counter, the decade counters output will go to +3.5V (TTL 1) at the count of eight then to 0 volts at the count of ten. This negative trasition is again passed across the closed contacts of the 1ms switch to the clock input of the first flip-flop. The flip-flop will change states, causing the Q output to go to 0 volts. A 0 volt output at Q will disable the main gate, enable the 4 line to 10 line counter, and clock the second flip-flop. The positive output at Q of the second flip-flop is applied to nand gate D where it is inverted. The output of gate D causes the transistor to conduct which will enable nand gate E to reset the decade counters.

3-19. The decade counter again starts to count the 10 kHz Clock Divider output, but this time the 4 line to 10 line counter is enabled so it converts the BCD input to single digit per line outputs. When the count reaches 2, nand gate C is enabled and the M (update) signal is sent to the Count and Display circuit. The count of 4 creates the R (reset) signal via nand gates A and B and 5 will reset the second flip-flop to start a new measurement cycle.

3-20. Nand gate F will supply a reset signal when the manual reset pushbutton is depressed. This action will start a new measurement cycle at any time.

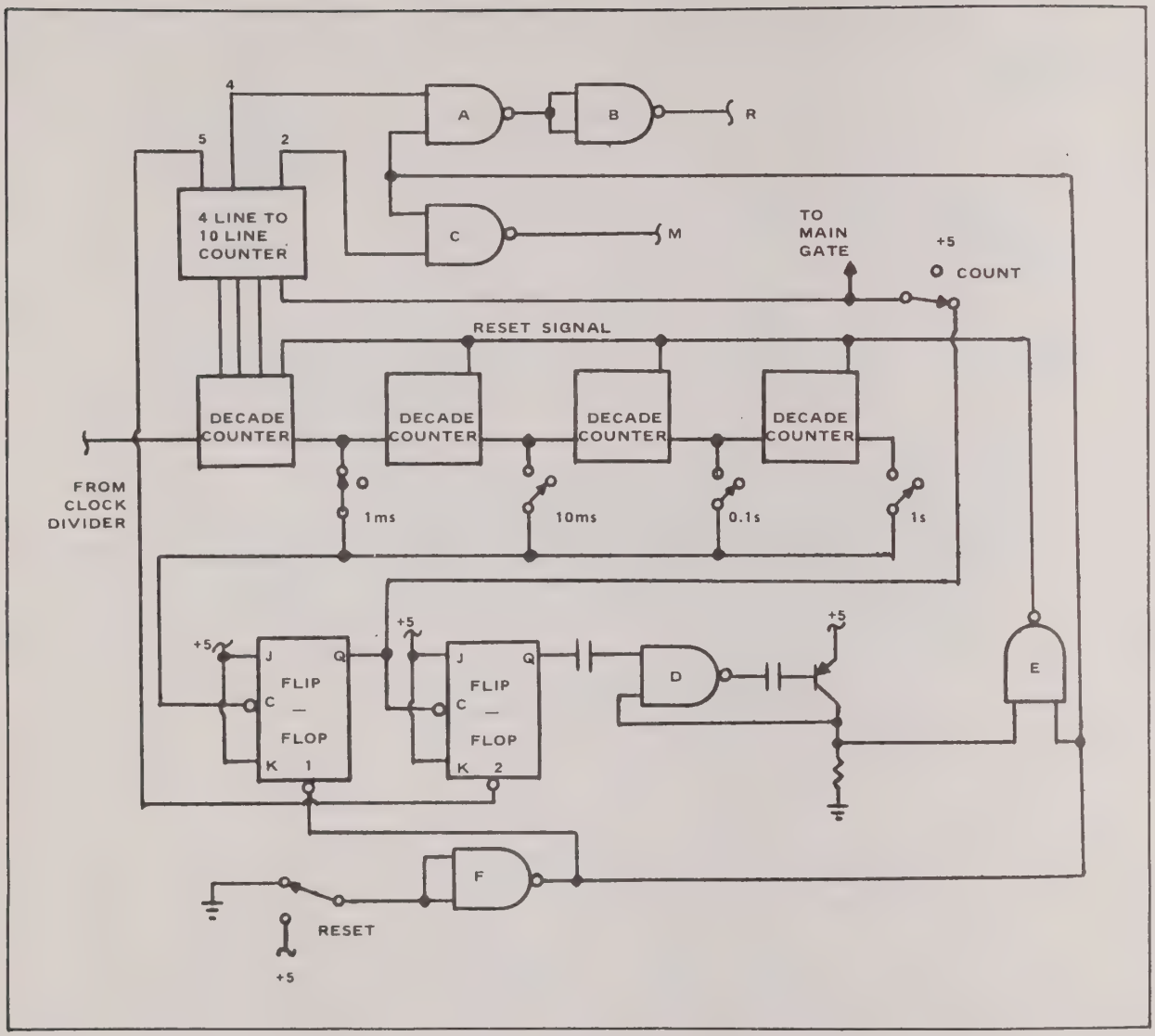

Figure 3-4. PROGRAM LOGIC

3-21. Count and Display

3-22. Figure 3-5 shows a basic block diagram of the Count and Display circuit. The diagram shows one of six identical digit display channels consisting of a BCD counter, a latch, a decoder driver, and a display tube.

3-23. When the Main Gate is opened by the Program Logic gate signal, the 1941A input signal is applied to the first of six, series connected, BCD counters. As the Main Gate closes at the end of gate time, the BCD counters contain the BCD equivalent of the frequency of the 1941A input signal. The update (M) signal from the Program Logic then opens the latch inputs and the information on the BCD counters will be used to update the display tube readout. The new BCD count in the latch is converted to a decimal equivalent by the decoder driver. The decoder driver output of each display channel will light the appropriate digit in each display tube.

3-24. If the input frequency count exceeds the display capacity, the output of the last BCD counter will set the overflow flip-flop. When the update (M) signal is applied to the nand gates the overflow indicator will light.

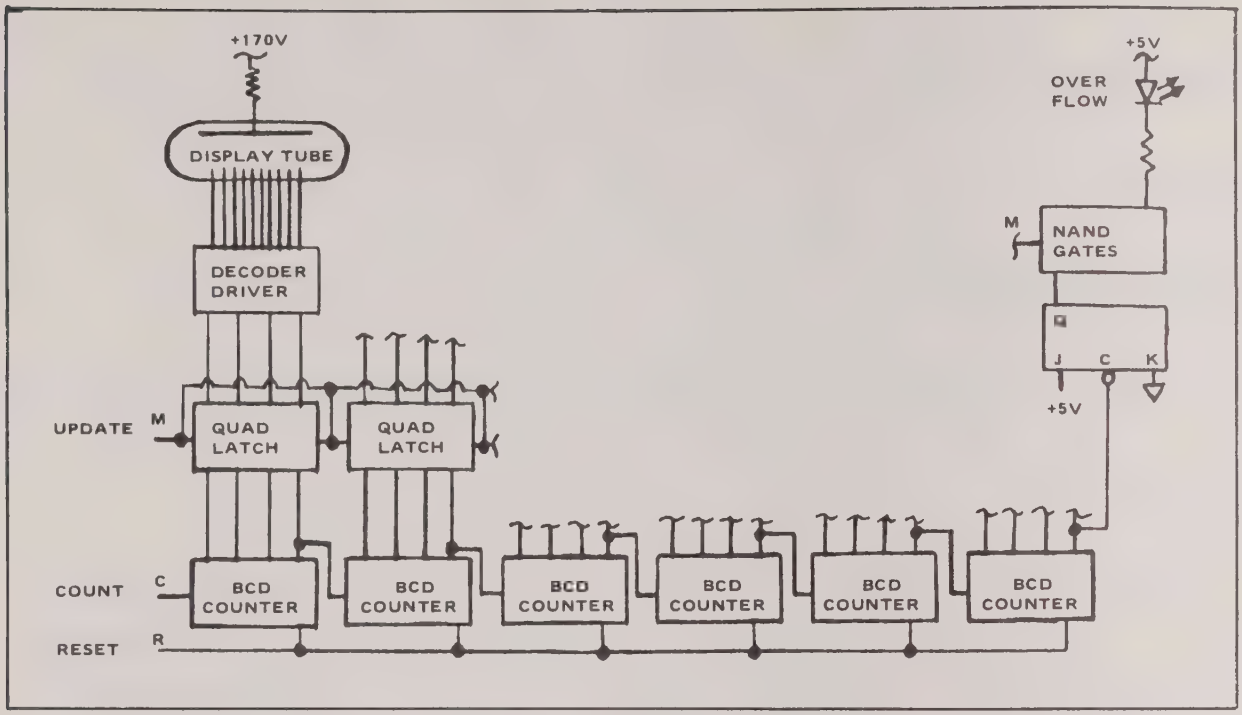

Figure 3-5. COUNT AND DISPLAY

Section
Maintenanc

4-1. INTRODUCTION

4-2. This section contains service and maintenance information for the Model 1941A Digital Counter. The performance test and calibration procedures are designed to maintain instrument operation within the specifications of section 1.

4-3. Service Information

4-4. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year from the date of delivery to the original purchaser. The WARRANTY is located at the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various world-wide locations. A list of authorized service centers is located at the rear of the manual. Shipping information is given in Section 2. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Cleaning

4-8. The Model 1941A should be cleaned periodically to remove accumulations of dust that may reduce proper heat dissipation by the components. The exterior should be cleaned using a cloth moistened with ordinary soap and water. Care should be taken when cleaning the interior of the unit, and should be done with clean dry air (about 20 psi). If the printed circuit boards require more than low pressure air to clean them, spray them first with Freon T.F. Degreaser (Miller Stephenson Co., Inc.) and then use low pressure air to remove the dirt.

4-9. Fuse Replacement

4-10. The input line power to the instrument is overload protected by a fuse installed on the rear panel. A decal giving the type and rating of the fuse is also located on the rear panel. If it becomes necessary to replace the fuse it can be removed from the fuse holder by pressing in on the fuse holder cap then twist it CCW. Insure the replacement fuse for 115 or 230V is the same value as specified on the rear panel decal.

4-11. MAINTENANCE ACCESS

4-12. The following procedure should be used to gain access to the interior sections of the Model 1941A.

CAUTION!

To prevent accidental shorting of components or line power, remove the AC line power input prior to disassembly.

4-13. Component Access

a. Remove the top dust cover. Four phillips head screws (two on each side) hold the cover in place.

b. Remove the bottom access cover.

4-14. Display Board Access

4-15. The display board can be lifted to provide access to the lower side, and to the components on the main PCB located under it. Lifting the display board for troubleshooting does not interfere with normal counter operation. The board can be lifted as follows:

a. Gently remove the Overflow LED from the mounting hole in the front panel.

b. Remove the four screws that secure the display board to the main PCB.

c. When lifting the display board for troubleshooting, make sure the components and land patterns are not being shorted by the board supports before energizing the unit.

4-16. TEST EQUIPMENT

4-17. The equipment recommended for calibration and maintenance of the 1941A is listed in Table 4-1. If the recommended equipment is not available, equipment with equivalent specifications can be used.

Table 4-1. TEST EQUIPMENT

EQUIPMENT TYPE	RECOMMENDED EQUIPMENT	FUNCTION
Multimeter	Fluke Model 8000	Calibration and Troubleshooting
Oscilloscope	Tektronix 465	Troubleshooting
Frequency Standard	10 MHz	Calibration and Performance Testing
Signal Generator	Wavetek 130 and Tektronix 191	Performance checks calibration and troubleshooting
Autotransformer	Variac	Performance checks calibration and troubleshooting

4-18. PERFORMANCE CHECKS

4-19. The following checks can be used to verify most electrical specifications on the Model 1941A. Each check includes an introduction which states the objectives and lists the required test equipment. Refer to Table 4-1 for the recommended equipment.

4-20. Should a problem with the operation of the counter be discovered, first determine if calibration is the cause. If the problem can not be corrected by recalibration, troubleshoot the instrument and repair as necessary.

4-21. Preliminary Operation

4-22. When a problem is suspected, the possibility of shorted components causing excess current drain and thus further damage should be guarded against. The following procedure will determine if the counter is drawing an excessive amount of current:

Required equipment: 1. Autotransformer

a. Connect the autotransformer to a 115 Vac line power source and set the output to zero volts.

b. Connect the counter input power cord to the autotransformer.

c. Depress the POWER switch to on.

d. Slowly increase the autotransformer output voltage to 115V (230V). The current draw indicated on the autotransformer should not exceed 25 mA.

4-23. Count and Reset Check

4-24. This procedure will determine if the counter is able to display each digit of the individual neon tubes, and check the operation of the reset circuitry.

Required equipment: Signal generator.

a. Connect the counter to a 115V (230V) power source.

b. Set the front panel controls:

POWER	–	depressed (on)
COUNT	–	depressed (in)
ATTEN	–	released (out)
FILTER	–	released (out)

c. Connect the signal generator output to the counter input jack.

d. Set the generator output to 5 Hz, 500 mV output.

e. Depress the RESET button, note that the display first resets to zero, then digitally counts the 5 Hz input.

f. Slowly increase the generator frequency output, and observe the display for proper counting sequence of all remaining digits.

g. As the displayed count nears the full display of 999999 note that the next count illuminates the OVERFLOW LED, and the display counts from 000000.

h. Depress the RESET button again, the OVERFLOW LED should go off and the display will return to zero.

4-25. Decimal Range Check

4-26. The range of each gate time is either expressed in MHz or kHz as indicated on the front panel. The ability of each range to properly display the input frequency can be varified using the following procedure.

NOTE!

When the signal generator frequency is set for steps c, e, and g note the exact counter reading. As the gate time is decreased in each case, the value of the frequency, as displayed on the counter, should not change.

Required equipment: Signal generator

a. Connect the output of the signal generator to the counter input jack.

b. Select the 1S gate time on the counter.

c. Set the signal generator output to 400 kHz at 1.0 volt. The counter should indicate 400.000 kHz.

d. Change the gate time to 0.1S. The display should now indicate 0400.00 kHz.

e. Increase the signal generator output frequency to 4.0 MHz. The 1941A display should indicate 4000.00 kHz.

f. Change the gate time to 10 MS. The counter should display 04.0000 MHz.

g. Increase the signal generator output frequency to 40.0 MHz. The counter should display 40.0000 MHz.

h. Change the gate time to 1 MS. The display should be 040.000 MHz.

4-27. TROUBLESHOOTING

4-28. The following information is provided to assist in locating malfunctions in the Model 1941A. It is recommended that the theory of operation in Section 3 be completely read and understood before troubleshooting is attempted.

4-29. Initial Troubleshooting

4-30. Troubleshooting begins by first performing a thorough inspection for, physically damaged parts, shorted component leads, or other obvious problems. It should be verified that the trouble is actually in the instrument and not caused by faulty external equipment or connections. For this reason the 1941A should be exercised as described in the "Performance Test" to determine the cause for the malfucntion. Carefull observation of the performance test results may indicate the particular problem area in the counter. If the 1941A will not meet the performance test standards, and the calibration of the unit is not at fault, the following information may be used to help isolate the cause of the malfunction.

4-31. Power Supply

4-32. Improper voltage outputs from any of the power supplies can cause the 1941A to exhibit various malfunction symptoms. For this reason it is recommended that a check of each power supply output voltage be made after the visual inspection.

Required equipment: Multi-meter

4-33. When checking the voltage outputs of each power supply the common of the multimeter should be connected to counter ground. A convenient ground is the signal return on the input jack. Figure 4-1 shows the points in the counter where the power supply output voltages may be monitored. The output of each supply should be within the following limits.

10V Supply	9.5V to 10.5V	When the input power is at 115VAC (230V)
170V Supply	170V to 185V	
5V Supply	4.75V to 5.25V	

4-34. If one or more of the power supply voltages are found to be out of the prescribed range, an evaluation of the results of the checks will help isolate the problem in the power supply section.

a. When all three supplies are effected, check the position of the input power select-switch, the fuse (F1), capacitors C20 and C21, and the primary of transformer T1.

b. If only the 10V and 170V supply voltages are effected check CR3, CR4, C22 and the secondary of T1.

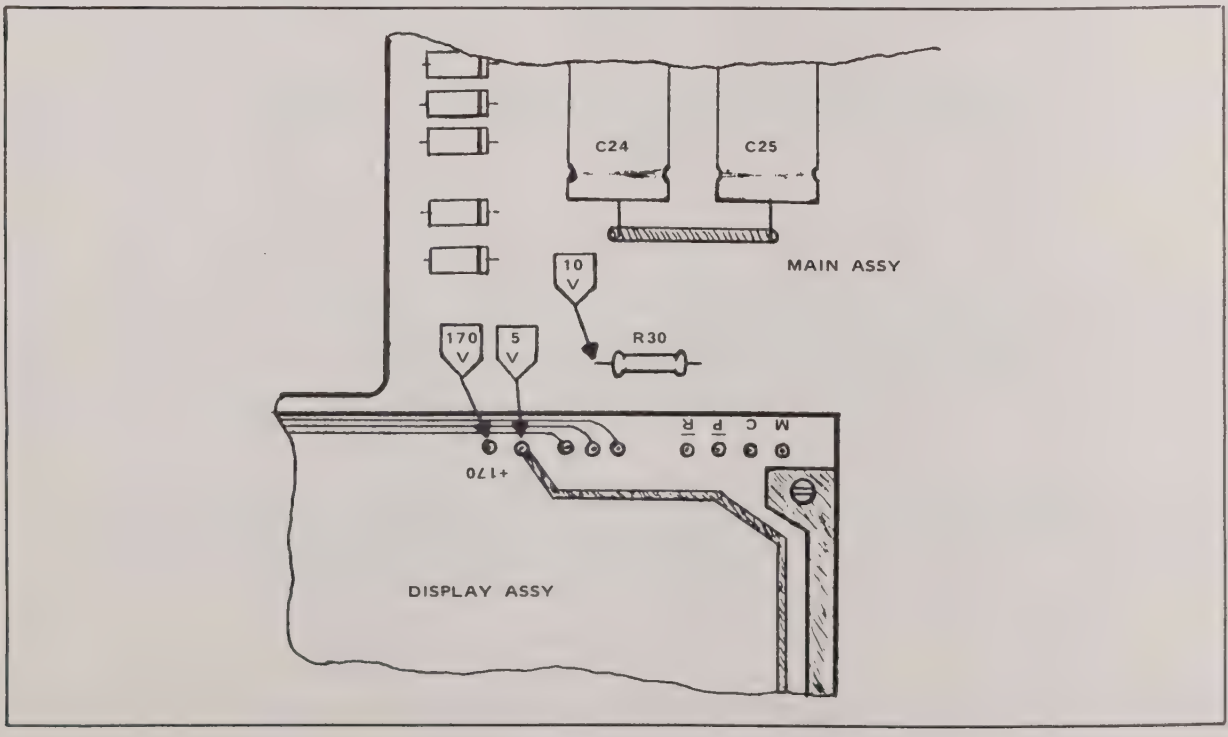

Figure 4-1. POWER SUPPLY VOLTAGE CHECKS

c. If the 5V supply is the only supply voltage that is improper the probable cause is U14 or one of the capacitors from C24-C27.

4-35. 10 MHz Clock

4-36. If the 1941A does not correctly determine the frequency of an input signal, the problem could be caused by the 10 MHz clock. It is possible to isolate the problem to the clock by checking other functions of the counter.

Required equipment: Frequency standard, (10 MHz)
Signal generator

4-37. The first thing to do is to see if the 1941A will count the cycles of a low frequency in the COUNT mode. This mode of operation does not use the 10 MHz Clock oscillator.

a. Connect the signal generator, adjusted for 10 Hz at 0.5 volts, to the INPUT jack of the counter.

b. Depress the COUNT button on the 1941A.

4-38. The display will digitize the input signal at a 10 Hz rate if the problem is in clock or Program Logic sections. To isolate the trouble to the 10 MHz clock itself an external 10 MHz clock must be substituted for the one in the counter

a. On the rear panel set the TB INT EXT switch to EXT, and connect the 10 MHz frequency standard to the EXT 10 MHz CLOCK Input jack.

b. Connect the output of the signal generator to the 1941A INPUT jack. Set the generator output for about 650 kHz at 0.5 volts.

c. Depress the 1s-kHz pushbutton on the 1941A front panel. The counter should accurately display the value of the 650 kHz input.

4-39. If the 1941A accurately displays the input frequency using an external 10 MHz clock signal. The malfunction must be in the internal clock oscillator. Using an oscilloscope the internal oscillators 10 MHz sinewave output can be checked at the emitter of Q5, then at the gate of Q4. The sinewave output of the crystal (Y1) should be about 10 volts p-p.

4-40. Program Logic and Clock Divider

4-41. The Program Logic section of the counter controls the timing of the signals that open and close the main gate, update the display, and reset the display. These control signals are used to automatically control the display when the RPM or one of the four gate time pushbuttons are selected. In the COUNT mode the signals that open the main gate and update the display are furnished through contacts of the COUNT pushbutton. For this reason most malfunctions in the Program Logic will not effect the COUNT mode of operation.

4-42. When the results of the 10 MHz Clock check (4-35) shows that the 1941A will properly count the number of cycles of an input signal in the COUNT mode, but will not properly display the frequency of an input signal using either an internal OR external time base, the malfunction is probably in the Program Logic or Clock Divider circuits. The following information can be used to isolate a malfunction within the Clock Divider or Program Logic.

Required equipment: Oscilloscope

a. Connect the scope input ground to the signal ground on the counter input jack.

b. Connect the scope input to pin 11 of U6.

NOTE!

It may be necessary to lift the display board in order to make the required connections in this procedure.

c. Set the scope controls for 1V/cm (X1 probe) and 20μs/cm. The scope should present a 3.5V square wave pulse 1cm wide, every 5cm. This would indicate that the Clock Divider is operating properly.

4-43. The Clock Divider output signal is divided by four series connected decade dividers (U9-U12), in the Program Logic. The proper operation of all four dividers can be checked using the following procedure.

Required equipment: Oscilloscope

a. Connect the scope input ground to the signal ground on the counter input jack.

b. Connect the scope input to pin 11 of U12.

c. With the scope controls set at .2 sec/cm and 2V/cm (X1 probe) the scope should present a 1.5cm square wave pulse approximately 4 volts high, every 5 cm.

4-44. The reset (R) and update (M) signal outputs from the Program Logic can be checked for operation. The automatic generation (in the RPM or gate time modes) of these two signals is an indication that the Program Logic is functioning properly. To check these two signals proceed as follows:

Required equipment: Oscilloscope

a. Select the 0.1s gate time pushbutton on the 1941A front panel.

b. Connect the scope input ground to the signal ground on the counter input jack.

NOTE!

The reset and update signals can be monitored at the right rear corner of the display board. The reset is marked $\overline{R}$ and the update is marked M.

c. Connect the scope input to the $\overline{R}$ signal pad.

d. With the scope controls set at .1 sec/cm and 1 volt/cm (X1 probe) the scope should present a signal level of approximately 3.5 volts with spike transitions to about zero volts each centimeter.

e. Move the scope input probe from the $\overline{R}$ to the M, signal pad. With the same scope settings the scope should present a signal level of approximately zero volts with positive spikes to about 3.5 volts every centimeter.

4-45. The Program Logic should generate one reset pulse (3.5V to 0V spike) and one update pulse (0V to 3.5V spike) for each gate time period. The proper operation of the Program Logic in other gate times can be checked by observing the change in the pulse rate of each signal when the gate time is changed.

4-46. Input Amp

4-47. A malfunction in the Input Amp would cause both the count and gate time modes of operation to present an improper display. The Input Amp can be checked using the following procedure:

Required equipment: Oscilloscope
Signal generator

a. Connect the scope input ground to the signal ground on the counter input jack.

b. Connect the scope input to the collector of Q3.

c. Apply a 10 kHz signal, from the signal generator, to the 1941A input jack.

d. With the scope controls set at 1V/cm (X1 probe) and 50μs/cm the presentation should be one complete cycle of a 3.5 volt square wave every centimeter.

4-48. Count and Display

4-49. The Count and Display circuit is supplied with a count signal from the Main Gate, a reset and update signal from the Program Logic, and +5 volt and +170V power from the Power Supply. The correctness of these inputs is determined by the procedures outlined in the preceeding paragraphs.

4-50. Of the five input signals to the Count and Display, the count signal is the one that may check out correctly in the preceeding paragraphs but still affect all six display tube readouts. The +5V and +170V power supply inputs, and the reset and update signals are connected to the six display channels in parallel. A display malfunction caused by one of these four inputs should affect only the display channel where the malfunction occurred.

4-51. The BCD count input and output of each display channel BCD counter and quad latch can be checked for proper information to find which channel or which component is causing the problem. The following procedure can be used to check the BCD signals of each component:

Required equipment: Signal generator
Oscilloscope

a. Connect the signal generator, adjusted for a 10 Hz output, to the 1941A input jack.

b. Depress the COUNT button on the front panel.

c. Connect the scope input ground to the signal ground on the counter input jack.

d. The scope input should be connected to each of the BCD output pins of the first BCD counter (A output pin 5, B pin 9, C pin 2, and D pin 12).

NOTE!

Each output pin of the BCD counter should go from a 0 volt to approximately +3.5 volts as it converts the count input square wave to BCD output. If the relationship of the BCD count to the displayed digit in the first BCD counter channel is too fast to be seen the signal generator input can be disconnected and the BCD equivalent of the digit displayed can be checked.

e. Connect the scope input to the BCD output pins of each of the other five BCD counters, and check the relationship of the BCD information to the displayed digit.

4-52. The quad latch BCD output can be checked in a similar manner to that of the BCD counter. The BCD outputs of each quad latch are; output A on pin 16, B pin 10, C pin 9, and D pin 15.

MAIN ASSY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	MAIN ASSY **Figure 5-1**						
C1	Cap, Mylar, .022μf 630V	369165			1		
C2	Cap, disc, 4.7pf 50V	362772			1		
C3, C17	Cap, elect, 47pf 1000V	369132			2		
C4, C12, C13, C16	Cap, elect, 22pf 250V	369157			4		
C5	Cap, disc, 300pf 50V	105734			1		
C6, C7, C8, C11, C15, C26, C27, C29	Cap, tant 20%, 10μf 16V	193623			8		
C9, C10	Cap, disc, 0.1μf 20V	369199			2		
C14	Cap, var, 22pf	369207			1		
C18, C19	Cap, disc, .01μf 20V	335786			2		
C20, C21	Cap, disc, .005μf 1200V	188003			2		
C22	Cap, elect, 4μf 400V	369215			1		
C23	Cap, elect, 220μf 25V	369181			1		
C24, C25	Cap, elect, 4700μf 10V	340893			2		
C28	Cap, disc, .001μf 20V	369140			1		
CR1, CR2	Diode 1N914	364224			2		
CR3, CR4, CR6, CR7, CR8, CR9	Diode 1N4004	368738			6		

MAIN ASSY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR5	Diode 1N758	180406			1		
L1	Inductor	147835			1		
Q1	Tstr, 2N5245	369611			1		
Q2, Q3	Tstr, 2N5771	369629			2		
Q4	Tstr, 5X3819	369637			1		
Q5, Q6	Tstr, 2N4274	369645			2		
Q7	Tstr, 5X4061	369652			1		
R1, R27	Res, comp ¼W 5% 1M	182204			2		
R2, R11, R43	Res, comp ¼W 5% 100k	148189			3		
R3, R25, R26	Res, comp ¼W 5% 180Ω	147942			3		
R4	Res, comp ½W 5% 120k	179598			1		
R5, R20, R21	Res, comp ¼W 5% 1k	148023			3		
R6	Res, comp ¼W 5% 10Ω	147868			1		
R7	Res, comp ¼W 5% 470Ω	147983			1		
R8, R17, R19, R30, R33	Res, comp ¼W 5% 390Ω	147975			5		
R9	Res, comp ¼W 5% 270Ω	160804			1		
R10	Res, comp ¼W 5% 10k	369553			1		

MAIN ASSY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R12, R13, R14, R15, R16, R18, R22, R23, R28, R29	Res, comp ¼W 5% 2.2k	148049			10		
R24	Res, comp ¼W 5% 22Ω	147884			1		
R31, R32	Res, comp ¼W 5% 47k	148163			2		
R34, R38, R42	Res, comp ¼W 5% 820Ω	148015			3		
R35	Res, comp ¼W 5% 39Ω	193391			1		
R36, R37	Res, comp 2W 10% 6.8k	110064			2		
R39, R40	Res, comp ¼W 5% 1.2k	190371			2		
R41	Res, comp ¼W 5% 22k	148130			1		
U1	IC, 10116	369702			1		
U2	IC, 74400	293068			1		
U3	IC, 7400	292953			1		
U4, U5, U6, U9, U10, U11, U12	IC, 7490	293159			7		
U7	IC, 7492	293225			1		
U8	IC, 7442	293142			1		
U13	IC, 7473	368571			1		
U14	IC, 7805	355107			1		
Y1	Crystal 10 MHz	369774			1		

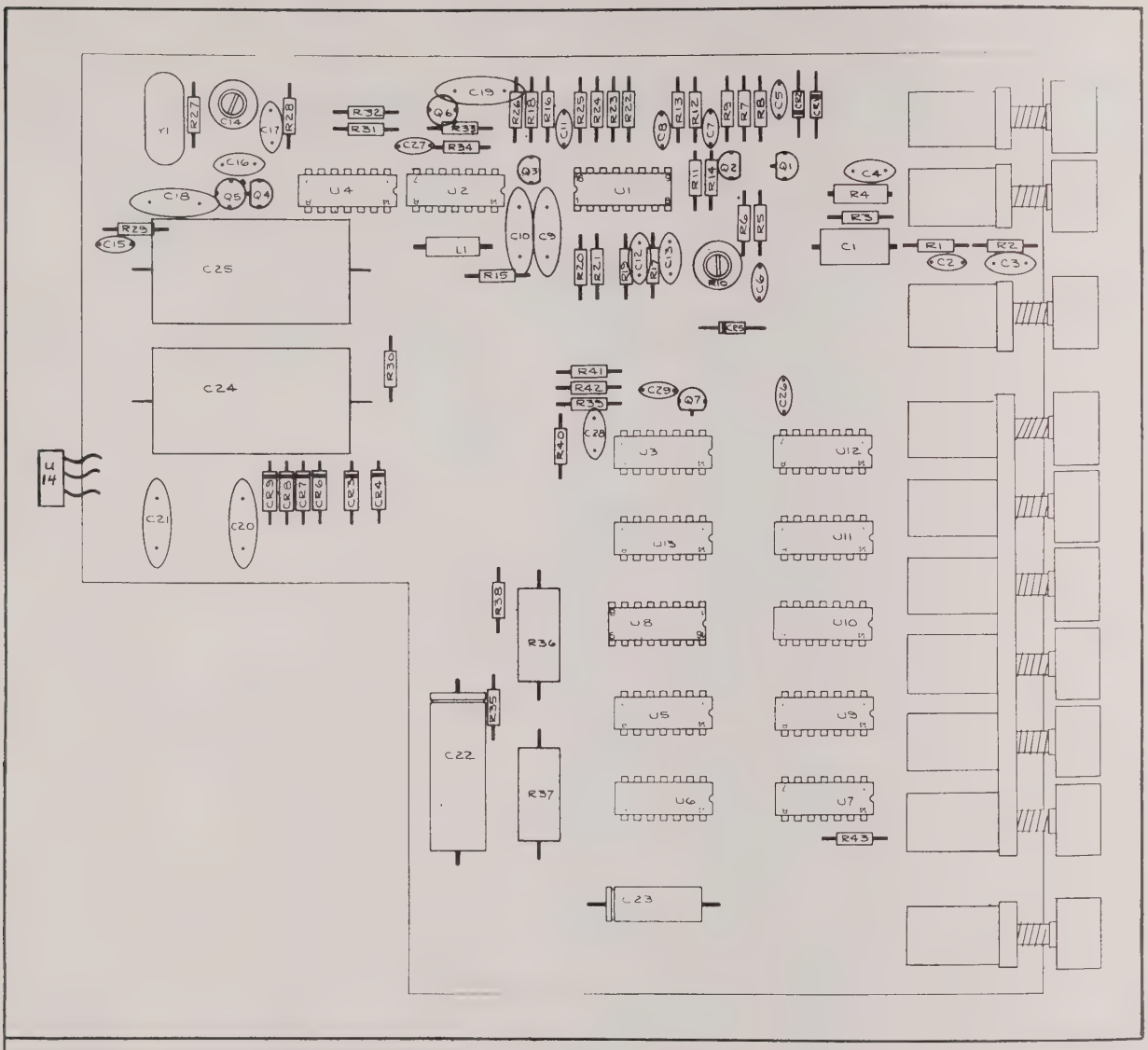

Figure 5-1 MAIN ASSY.

DISPLAY ASSY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	DISPLAY ASSY **Figure 5-2**						
C30	Cap, tant 10μf 20% 16V	193623			1		
R44, R46, R48, R50, R52, R54	Res, comp ¼W 5% 15k	148114			6		
R45, R47, R49, R51, R53, R55	Res, comp ¼W 5% 10M	194944			6		
R56	Res, comp ¼W 5% 82Ω	149484			1		
U15, U18, U21, U24, U27, U30	IC, 74196N	320754			6		
U16, U19, U22, U25, U28, U31	IC 7475	368522			6		
U17, U20, U23, U26, U29, U32	IC 74141	369710			6		
U33	IC 7473	368571			1		
U34	IC 7400N	292953			1		
V1, V2, V3, V4, V5, V6	Display tube	369801			6		

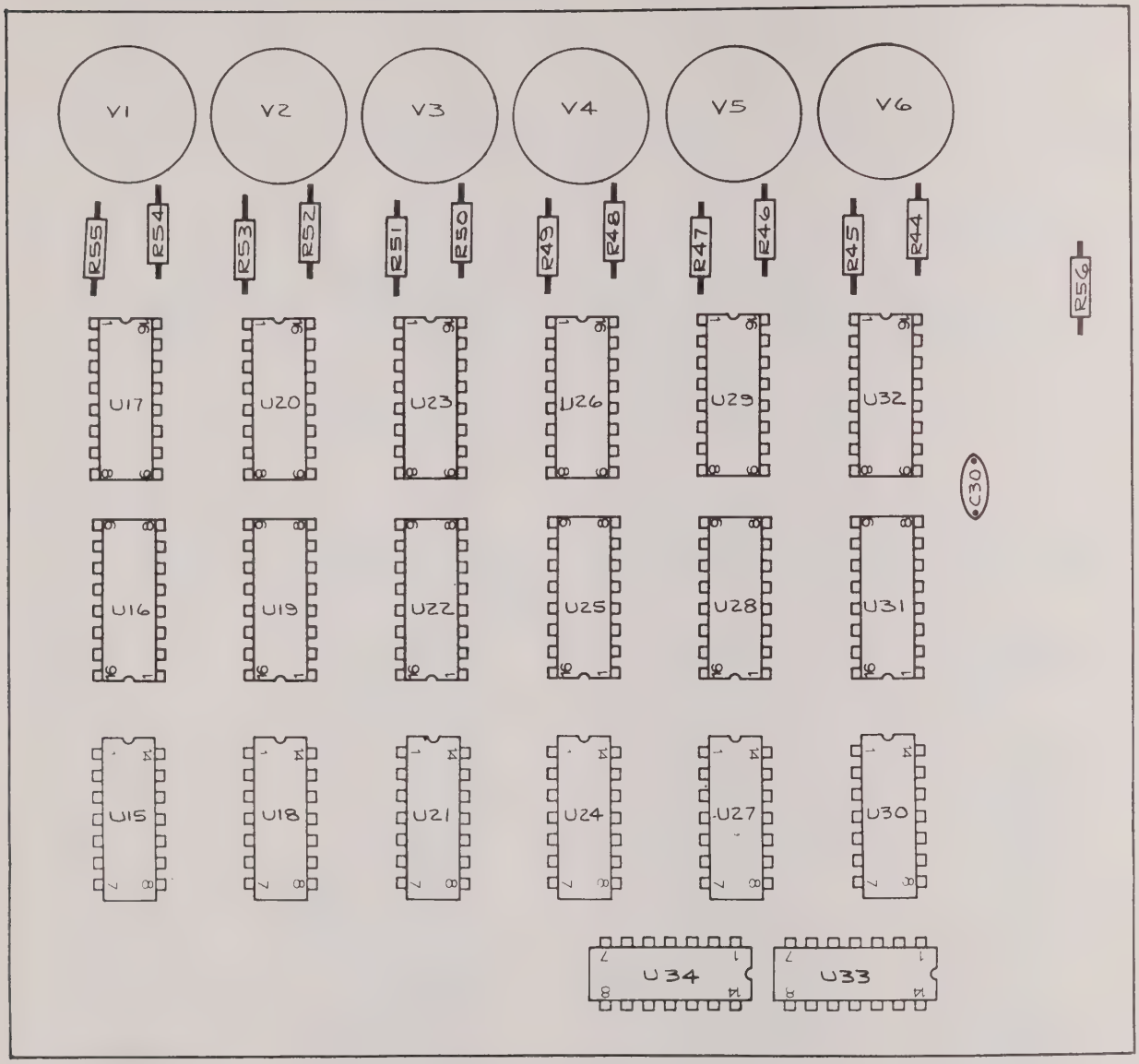

Figure 5-2 DISPLAY ASSY.

Appendix A

Federal Supply Code for Manufacturers

A-1. CODE TO NAME

A-2. The following five digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Westlake, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
00686	Film Capacitors Passaic, New Jersey
00779	AMP Inc. Harrisberg, Pennsylvania
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01281	TRW Semiconductors Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas
01686	RCL Electronics Inc. Manchester, New Hampshire
01730	Deleted
01884	Dearborn Electronics Inc. Orlando, Florida
02114	Ferroxcube Corp. Saugerties, New York
02606	Replaced by 15801
02660	Amphenol-Borg Elect. Corp. Broadview, Illinois
02799	Arco Capacitors, Inc. Torrence, California
03508	General Electric Co. Semiconductor Products Syracuse, New York
03614	Replaced by 71400
03651	Replaced by 44655
03797	Eldema Corp. Compton, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03888	Pyrofilm Resistor Co., Inc. Cedar Knolls, New Jersey
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Replaced by 72136
04202	Replaced by 81312
04217	Essex Wire Corp. Wire & Cable Div. Anaheim, California
04221	Aemco, Div. of Midtex Inc. Mankato, Minnesota
04222	Aerovox Corp. (H-Q) Myrtle Beach, South Carolina
04645	Replaced by 75376
04713	Motorola Semiconductor Products Inc. Phoenix, Arizona
05082	Replaced by 94154
05236	Jonathan Mfg. Co. Fullerton, California
05277	Westinghouse Electric Corp. Semiconductor Dept. Youngwood, Pennsylvania
05278	Replaced by 43543
05397	Union Carbide Corp. Electronics Div. Cleveland, Ohio
05279	Southwest Machine & Plastic Co. Los Angeles, California
05397	Union Carbide Corp. Electronics Div. New York, New York
05571	Sprague Electric Co. Pacific Div. Los Angeles, California
05704	Alac, Inc. Glendale, California
05820	Wakefield Engineering Ind. Wakefield, Massachusetts
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Replaced by 63743
06473	Amphenol Space & Missile Sys. Chatsworth, California
06555	Beede Electrical Instrument Co. Penacook, New Hampshire
06739	Electron Corp. Littletown, Colorado
06743	Clevite Corp. Cleveland, Ohio
06751	Semcor Div. Components Phoenix, Arizona
06860	Gould National Batteries Inc. City of Industry, California
06980	Varian
06980	Varian-Eimac San Carlos, California
07115	Replaced by 14674
07138	Westinghouse Electric Corp., Electronic Tube Division Elmira, New York
07256	Silicon Transistor Corp. Garden City, New York
07263	Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Teledyne Corp. (Continental Device) Hawthorne, California
08225	Industro Transistor Corp. Long Island City, New York
08530	Reliance Mica Corp. Brooklyn, New York
08792	Discontinued
08806	General Electric Co. Miniature Lamp Dept. Cleveland, Ohio
08863	Nylomatic Corp. Norrisville, Pennsylvania
08988	Skottie Electronics Inc Archbald, Pennsylvania
09353	C and K Components Watertown, Massachusetts
09423	Scientific Components, Inc Santa Barbara, California
09922	Burndy Corp Norwalk, Connecticut
11236	CTS of Berne Berne, Indiana
11237	Chicago Telephone of Calif., Inc. (CTC) Paso Robles, California
11358	Discontinued
11403	Best Products Co Chicago, Illinois

11503 Keystone Mfg.
Div. of Avis Industrial Corp.
Warren, Michigan

11726 Qualidyne Corp.
Santa Clara, California

12014 Chicago Rivet & Machine Co.
Bellwood, Illinois

12040 National Semiconductor Corp.
Danburry, Connecticut

12060 Diodes, Inc.
Chatsworth, California

12136 Philadelphia Handle Co.
Camden, New Jersey

12323 Presin Co., Inc.
Shelton, Connecticut

12327 Freeway Washer & Stamping Co.
Cleveland, Ohio

12400 Replaced by 75042

12617 Hamlin Inc.
Lake Mills, Wisconsin

12697 Clarostat Mfg. Co.
Dover, New Hampshire

12749 James Electronics
Chicago, Illinois

12856 Micrometals
Sierra Madre, California

12954 Dickson Electronics Corp.
Scottsdale, Arizona

12969 Unitrode Corp.
Watertown, Massachusetts

13103 Thermalloy Co.
Dallas, Texas

13511 Amphenol Corp.
Los Gatos, California

13606 Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839 Replaced by 23732

14099 Semtech Corp.
Newbury Park, California

14193 California Resistor Corp.
Santa Monica, California

14298 American Components, Inc.
Conshohocken, Pennsylvania

14655 Cornell-Dubilier Electronics
Newark, New Jersey

14674 Discontinued, see 16299

14752 Electro Cube Inc.
San Gabriel, California

14869 Replaced by 96853

15636 Elec-Trol Inc.
Northridge, California

15801 Fenwal Electronics Inc.
Framingham, Massachusetts

15818 Amelco Semiconductor
Div. of Teledyne Inc.
Mountain View, California

15849 USI CO. Inc.
Mt. Vernon, New York

15898 International Business
Machines (IBM)
Essex Junction, Vermont

15909 Replaced by 17870

16299 Corning Glass
Raleigh, North Carolina

16332 Replaced by 28478

16473 Cambridge Scientific Ind. Inc.
Cambridge, Maryland

16742 Paramount Plastics
Downey, California

16758 Delco Radio
Div. of General Motors
Kokomo, Indiana

17069 Circuit Structures Lab.
Upland, California

17856 Siliconix, Inc.
Sunnyvale, California

17870 Daven-Div of Thomas A. Edison
Ind. – McGraw - Edison Co.
Manchester, New Hampshire

18083 Deleted

18178 Vactec Inc.
Maryland Heights, Missouri

18612 Vishay Intertechnology
Inc.
Malvern, Pennsylvania

18736 Voltronics Corp.
Hanover, New Jersey

19429 Discontinued, use 89536

19451 Perine Machinery & Supply Co.
Seattle, Washington

19701 Electra Mfg. Co.
Independence, Kansas

20584 Enochs Mfg. Co.
Indianapolis, Indiana

20891 Self-Organizing Systems,
Inc.
Dallas, Texas

22767 ITT Semiconductors
Div. of ITT
Palo Alto, California

23732 Tracor
Rockville, Maryland

23880 Stanford Applied Engrng.
Santa Clara, California

24248 Southco
Div. of South Chester Corp.
Lester, Pennsylvania

24655 General Radio Co.
West Concord, Massachusetts

24759 Lenox-Fugle Electronics
Plainfield, New Jersey

25403 Amperex Electronic Corp.
Semiconductor & Receiving
Tube Division
Slatersville, Rhode Island

27014 National
Semiconductor
Corp.
Santa Clara, California

27264 Molex Products
Downers Grove, Illinois

28425 Bohannon Industries
Fort Worth, Texas

28478 Deltrol Controls,
Corp.
Milwaukee, Wisconsin

28480 Hewlett Packard
Co.
Palo Alto, California

28520 Heyman Mfg. Co.
Kenilworth, New Jersey

29083 Monsanto, Co., Inc.
Santa Clara, California

30323 Illinois Tool
Works, Inc.
Chicago, Illinois

32539 Mura Corp.
Great Neck, New York

32767 Griffith Plastic
Products Co.
Burlingame, California

32879 Advanced Mechanical
Components
Northridge, California

32897 Erie Technological
Products, Incorporated
Frequency Control Div.
Carlisle, Pennsylvania

33173 General Electric
Co., Tube Dept.
Owensboro, Kentucky

34333 Silicon General
Westminister, California

34335 Advanced Micro
Devices.
Sunnyvale, California

37942 Mallory, P. R. & Co., Inc.
Indianapolis, Indiana

42498 National Company
Melrose, Massachusetts

43543 Nytronics Inc.
Transformer Co. Div.
Alpha, New Jersey

44655 Ohmite Mfg. Co.
Skokie, Illinois

49671 Radio Corp. of America
New York, New York

49956 Raytheon Company
Lexington, Maine

53021 Sanamo Electric Co.
Springfield, Illinois

55026 Simpson Electric Company
Chicago, Illinois

56289 Sprague Electric Co.
North Adams, Massachusetts

58474 Superior Electric Co.
Bristol, Connecticut

60399 Torrington Mfg. Co.
Torrington, Connecticut

62460 Deleted

63743 Ward Leonard Electric Co.
Mount Vernon, New York

64834 West Mfg. Co.
San Francisco, California

65092 Weston Instruments Inc.
Newark, New Jersey

66150 Winslow Tele-Tronics Inc.
Asbury Park, New Jersey

70563 Amperite Company
Union City, New Jersey

70903 Belden Mfg. Co.
Chicago, Illinois

71002 Birnbach Radio Co., Inc.
New York, New York

71236 "ELMENCO"
Willimantic, Connecticut

71400 Bussmann Mfg.
Div. of McGraw - Edison Co.
Saint Louis, Missouri

71450 CTS Corp.
Elkhart, Indiana

71468 ITT Cannon Electric Inc.
Los Angeles, California

71482 Clare, C. P. & Co.
Chicago, Illinois

71590 Centralab
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707 Coto Coil Co., Inc.
Providence, Rhode Island

71744 Chicago Miniature Lamp Works
Chicago, Illinois

71785 Cinch Mfg. Co. & Howard
B. Jones Div.
Chicago, Illinois

72005 Driver, Wilber B., Co.
Newark, New Jersey

72092 Replaced by 06980

72136 Electro Motive Mfg. Co.
Willimantic, Connecticut

72259 Nytronics Inc.
Berkeley Heights, New Jersey

72354 Deleted

72619 Dialight Corp.
Brooklyn, New York

72653 G. C. Electronics
Rockford, Illinois

72665 Replaced by 90303

72794 Dzus Fastener Co., Inc.
West Islip, New York

72928 Gudeman Co. (Gulton
Industries)
Chicago, Illinois

72982 Erie Tech. Products Inc.
Erie, Pennsylvania

73138 Beckman Instruments Inc.
Helipot Division
Fullerton, California

73293 Hughes Aircraft Co.
Electron Dynamics Div.
Torrence, California

73445 Amperex Electronic Corp.
Hicksville, New York

73559 Carling Electric Inc.
Hartford, Connecticut

73586 Circle F Industries
Trenton, New Jersey

73734 Federal Screw Products, Inc.
Chicago, Illinois

73743 Fischer Special Mfg. Co.
Cincinnati, Ohio

73899 JFD Electronics Co.
Brooklyn, New York

73949 Guardian Electric Mfg. Co
Chicago, Illinois

74199 Quam Nichols Co.
Chicago, Illinois

74217 Radio Switch Corp.
Marlboro, New Jersey

74276 Signalite Inc.
Neptune, New Jersey

74306 Piezo Crystal Co.
Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970 Johnson, E. F., Co.
Waseca, Minnesota

75042 IRC Inc. (Div. of TRW)
Philadelphia, Pennsylvania

75376 Kurz-Kasch, Inc.
Dayton, Ohio

75382 Kulka Electric Corp.
Mount Vernon, New York

75915 Littlefuse Inc.
Des Plaines, Illinois

76854 Oak Mfg. Co.
Crystal Lake, Illinois

77342 Potter & Brumfield
Div. of Amer. Machine & Foundry
Princeton, Indiana

77969 Rubbercraft Corp. of Calif. LTD.
Torrance, California

78189 Shakeproof
Div. of Illinois Tool Works
Elgin, Illinois

78277 Sigma Instruments, Inc.
South Braintree, Massachusetts

78488 Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553 Tinnerman Products
Cleveland, Ohio

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

79963 Zierick Mfg. Corp.
New Rochelle, New York

80031 Mepco
Div. of Sessions Clock Co.
Morristown, New Jersey

80145 API Instruments Co.
Chesterland, Ohio

80183 Sprague Products
North Adams, Massachusetts

80294 Bourns Inc.
Riverside, California

80583 Hammarlund Co., Inc.
Mars Hill, North Carolina

80640 Stevens, Arnold Inc.
Boston, Massachusetts

81073 Grayhill Inc.
La Grange, Illinois

81590 Korry Mfg. Co.
Seattle, Washington

81312 Winchester Electronics
Div. of Litton Industries
Oakville, Connecticut

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
Los Angeles, California

82376 Deleted

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric Corp.
Frederick, Maryland

82872 Roanwell Corp.
New York, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 ITT Wire & Cable Div.
Pawtucket, Rhode Island

83003 Varo Inc.
Garland, Texas

83298 Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of America
New Haven, Connecticut

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740 Union Carbide Corp.
Consumer Products Div.
New York, New York

84171 Arco Electronics, Inc.
Great Neck, New York

84411 TRW
Ogallala, Nebraska

86577 Precision Metal Products
Stoneham, Massachusetts

86684 Radio Corp. of America
Electronic Components & Devices
Harrison, New Jersey

86689 Deleted

87034 Marco-Oak Inc.
Anaheim, California

88245 Litton Products Inc.
Van Nuys, California

88419 Use 14655

88690 Replaced by 04217

89536 Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730 Replaced by 08806

90201 Mallory Capacitor Co.
Indianapolis, Indiana

90215 Best Stamp & Mfg. Co
Kansas City, Missouri

90211 Square D Co.
Chicago, Illinois

90303 Mallory Battery Co.
Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Replaced by 58474

91502 Associated Machine
Santa Clara, California

91637 Dale Electronics Inc.
Columbus, Nebraska

91662 Elco Corp.
Willow Grove, Pennsylvania

91737 Gremar Mfg Co., Inc. (ITT)
Woburn, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91836 King's Electronics
Tuckahoe, New York

91929 Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934 Müller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products
Semiconductor Products Div
Woburn, Massachusetts

94145 Replaced by 49956

94154 Tung-Sol
Div. of Wagner Electric Corp.
Newark, New Jersey

95146 Alco Electronics Products Inc.
Lawrence, Massachusetts

95263 Leecraft Mfg. Co.
Long Island City, New York

95264 Replaced by 98278

95275 Vitramon Inc.
Bridgeport, Connecticut

95303 Radio Corp. of America
Solid State & Receiving Tube Div.
Cincinnati, Ohio

95354 Methode Mfg. Corp.
Rolling Meadows, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

95987 Weckesser Co. Inc.
Chicago, Illinois

96733 San Fernando Electric Mfg. Co.
San Fernando, California

96853 Rustrak Instrument Co.
Manchester, New Hampshire

96881 Thomson Industries, Inc.
Manhasset, New York

97540 Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Los Angeles, California

97913 Industrial Electronic Hdware Corp.
New York, New York

97945 White, S. S. Co.
Plastics Div.
New York, New York

97966 Replaced by 11358

98094 Replaced by 49956

98159 Rubber-Teck, Inc.
Gardena, California

98278 Microdot Inc.
Pasadena, California

98291 Sealectro Corp.
Conhex Div.
Mamaroneck, New York

98388 Accurate Rubber & Plastics
Culver City, California

98743 Replaced by 12749

98925 Deleted

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99515 Marshall Industries
Capacitor Div.
Monrovia, California

99779 Barnes Corp.
Lansdowne, Pennsylvania

Appendix B

List of Abbreviations

alternating current	ac
ampere	A
assembly	assy
binary coded decimal	bcd
bel	B
capacitor	cap
centimeter	cm
ceramic	cer
clockwise	cw
common-mode rejection ratio	cmrr
composition	comp
counterclockwise	ccw
decibel	dB
degree Celsius	°C
degree Fahrenheit	°F
digital voltmeter	dvm
direct current	dc
electrolytic	elect
external	ext
farad	F
field effect transistor	FET
germanium	Ge
giga (10^9)	G
gigahertz	GHz
ground	gnd
guard	gd
henry	H
hertz	Hz
high frequency	hg
hour	h
inch	in
integrated circuit	IC
intermediate frequency	if
internal	intl
kilo (10^3)	k
kilohertz	kHz
kilohm	kΩ
kilovolt	kV
low frequency	lf
maximum	max
mega (10^6)	M
megahertz	MHz
megohm	MΩ
meter	m
micro (10^{-6})	μ
microsecond	μs
milli (10^{-3})	m
milliamperes	mA
millimeter	mm
millisecond	ms
millivolt	mV
minimum	min
nano (10^{-9})	n
nanosecond	ns
negative	neg
ohm	Ω
oscilloscope	scope
parts per million	ppm
peak-to-peak	p-p
pico (10^{-12})	p
picofarad	pF
plus or minus	±
positive	pos
plastic	plstc
printed circuit board	pcb
radio frequency	rf
root mean square	rms
second (time)	s
serial number	SN
silicon	Si
tantalum	Ta
temperature coefficient	TC
tera (10^{12})	T
transformer	xfmr
transistor	xstr
ultra high frequency	uhf
variable	var
very high frequency	vhf
very low frequency	vlf
volt	V
voltage controlled oscillator	vco
watt	W
wirewound	ww

Appendix C

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HUNTSVILLE
BCS Associates, Inc.
3322 S. Memorial Parkway
P.O. Box 1273
Tel. (205) 881-6220
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SEATTLE
Showalter-Judd, Inc.
5616 4th Ave. South
Tel. (206) 762-2310
Zip 98108

ARIZONA
PHOENIX
Barnhill Associates
7329 E. Stetson Dr.
Tel. (602) 947-7841
Scottsdale, AZ 85251

CALIFORNIA
LOS ANGELES
Instrument Specialists, Inc.
1109 S. Central Ave.
Glendale, California 91204
Tel. (213) 245-9404

SANTA CLARA
Instrument Specialists, Inc.
2359 De La Cruz Blvd.
Tel. (408) 244-1505
Zip 95050

SAN DIEGO
Instrument Specialists, Inc.
4805 Mercury St., Ste. 1
Tel. (714) 565-2555
Zip 92111

COLORADO
DENVER
Barnhill Associates
1170 S. Sheridan Blvd.
Tel. (303) 934-5505
Zip 80226

CONNECTICUT
HARTFORD
Instrument Representatives, Inc.
P.O. Box 165
Glastonbury, Connecticut 06033
Tel. (203) 633-0777

FLORIDA
ORLANDO
BCS Associates, Inc.
940 N. Fern Creek Ave.
Tel. (305) 896-4881
Zip 32803

HAWAII
HONOLULU
Industrial Electronics, Inc.
646 Queen Street
P.O. Box 135
Tel. (808) 533-6095
Zip 96817

ILLINOIS
CHICAGO
Cozzens & Cudahy, Inc.
1301 N. Rand Rd.
Des Plaines, IL 60016
Tel. (312) 298-3600

INDIANA
INDIANAPOLIS
Cozzens & Cudahy, Inc.
Port O'Call Executive Ctr.
21 Beachway Drive
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Zip 46224

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Kensington, Maryland 20795
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BOSTON
Instrument Representatives, Inc.
109 Massachusetts Ave.
Lexington, MA 02173
Tel. (617) 861-8620

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DETROIT
WKM Associates, Inc.
1474 East Outer Dr.
Tel. (313) 892-2500
Zip 48234

MINNESOTA
MINNEAPOLIS
Cozzens & Cudahy, Inc.
10800 Lyndale Ave. S.
Tel. (612) 884-4336
Zip 55420

MISSOURI
ST. LOUIS
Cozzens & Cudahy, Inc.
P.O. Box 10013
Lambert Field - Zip 63145
Tel. (314) 423-1234

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NEWARK
SBM Representatives
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Union, New Jersey 07083
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ALBUQUERQUE
Barnhill Associates
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Tel. (505) 299-7658
Zip 87112

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NEW YORK
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28 Hobby Street
Pleasantville, N.Y. 10570
Tel. (914) 769-1811

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SBM Representatives
4515 Culver Rd.
Tel. (716) 226-1400
Zip 14622

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Tel. (919) 273-1918
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WKM Associates, Inc.
16141 Puritas Ave.
Tel. (216) 267-0445
Zip 44135

DAYTON
WKM Associates, Inc.
6073 Far Hills Ave.
Tel. (513) 434-7500
Zip 45459

PENNSYLVANIA
PHILADELPHIA
Electronic Marketing Assoc.
210 Goddard Blvd., Ste. 100
King of Prussia, Pennsylvania
Tel. (215) 248-5050
Zip 19406

PITTSBURGH
WKM Associates, Inc.
90 Clairton Blvd.
Tel. (412) 892-2953
Zip 15236

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Suite 220
312 N. Central Express Wy.
Richardson, Texas 75080
Tel. (214) 231-2573

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Barnhill Associates
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3810 Westheimer
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Zip 77027

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Tel. (206) 762-2310
Zip 98108

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CALGARY
Allan Crawford Associates, Ltd.
640 - 11th Ave. S.W.
Tel. (403) 261-0780

ONTARIO
MALTON
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6427 Northam Drive
Tel. (416) 678-1500

OTTAWA, 3
Allan Crawford Associates, Ltd.
376 Churchill Ave., Suite 106
Tel. (613) 829-9651

QUEBEC
LONGUEUIL
Allan Crawford Associates, Ltd.
157 (rue) St. Charles Street W.
Tel. (514) 670-1212

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Coasin S.A.
Virrey del Pino 4071
Buenos Aires, Argentina

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Elmeasco Instruments
P.O. Box 334
Brookvale, N.S.W. Australia 2100

AUSTRIA
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Lederergasse 16
1080 Vienna, Austria

BELGIUM
C.N. Rood S.A.
37 Place de Jamblinne de Meux
1040 Brussels, Belgium

BRAZIL
Ambriex S.A.
Rue Ceara, 104 - 2.º e 3.º Andares
ZC - 29
Rio de Janeiro GB, Brazil

Ambriex S.A.
Rua Tupi, 535
01233 Sao Paulo SP, Brazil

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606 Calle Aboy
San Juan, Puerto Rico 00907

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Casilla 14588 - Correo 15
Santiago, Chile

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May Lee Industries, Inc.
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New York, N.Y. 10016

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Apartado Aereo 90687
Bogota 8, Colombia

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Copenhagen Ø, Denmark

ECUADOR
Proteco Coasin Cia., Ltda.
Apartado 228A
Quito, Ecuador

FINLAND
Oy Findip AB
P.O. Box 25
00521 Helsinki 52, Finland

FRANCE
M.B. Electroniques S.A.
29, Rue Emile Duclaux
92, Suresnes
France

GERMANY
Fey Elektronische Messgerate
8 Muenchen 19
Horemansstrasse 28
West Germany

GREECE
Marios Dallegglo Representations
2 Alopekis Street
Athens 19 Greece

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P.O. Box 56
Hong Kong

INDIA
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69/A Nepean Sea Road
Bombay-6 India

IRAN
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20 Salm Road, Roosevelt Ave.
Tehran, Iran

ISRAEL
R.D.T. Electronics Engineering Ltd.
19 Prof. Shor Street
Tel-Aviv, Israel

ITALY
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Rome, Italy

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P.O. Box 5014
Tokyo International
Tokyo 100-31, Japan

Suzuki Bldg.
2-38 Junkeicho-dori
Minami-ku, Osaka

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Asia Science & Co.
Internaltion P.O. Box 1250
Seoul, Korea

MALAYSIA
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Kota Kinabalu
East Malaysia

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Petaling Jaya, Selangor
West Malaysia

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Eugenia 408
Departments 1 y 5
Mexico 12, D.F.
Mexico

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13 - Cort van der Lindenstraat
Rijswijk (Z.H.) 2100
Netherlands

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Ledeboerstraat 27
Industrieterrein Noord
Tilburg, Netherlands

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C.P.O Box 2630
Auckland 1, New Zealand

NIGERIA
Deemtee Electrotechnics Ltd.
P.O. Box 3073
Lagos, Nigeria

NORWAY
Morgenstierne & Co. A/S
P.O. Box 6688 Rodeløkka
Oslo 5, Norway

PAKISTAN
Pak International Operations
505 Muhammadi House-McLeod Rd.
P.O. Box 5323
Karachi, Pakistan

PERU
Importaciones y Representaciones Electronicas S.A.
Avda. Franklin D. Roosevelt 105
Lima 1, Peru

PORTUGAL
Equipamentos De Laboratorio, Lda.
P.O. Box 1100
Lisbon, Portugal

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Singapore 5, Singapore

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Johannesburg
Republic of South Africa

P.O. Box 3641
Cape Town

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Enrique-Larretta 12
Madrid 16, Spain

SWEDEN
Teleinstrument AB
P.O. Box 490
S-16204 Vallingby
Sweden

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Kontron Electronic A.G.
Bernerstrasse Sud 169
8048 Zurich
Switzerland

TAIWAN-REPUBLIC OF CHINA
Heighten Trading Company, Ltd.
P.O. Box 1408
Taipei, Taiwan 104

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30 Patpong Avenue
Suriwong
Bangkok, Thailand

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Fluke International Corp.
Garnett Close
Watford, WD2 4TT
England

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Coasin Uruguay S.A.
Cerrito 617 - 4º Pisco
Montevideo, Uruguay

U.S.S.R.
Codevintec Pacific Inc.
6263 Variel
Woodland Hills, Calif. 91364

VENEZUELA
Coasin C.A.
Apdo. Postal 50939
Sabana Grande No.1
Caracas 105
Venezuela

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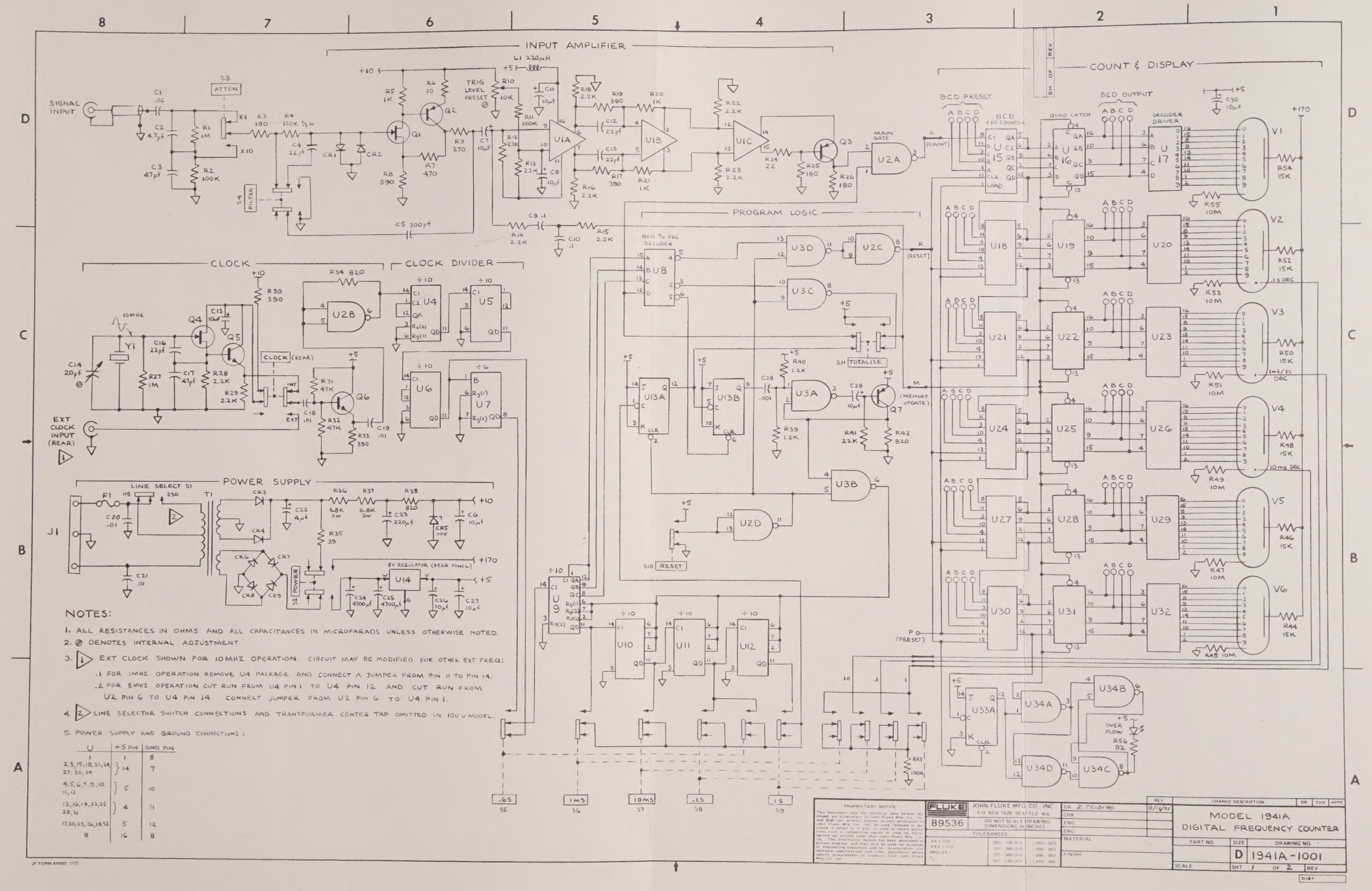

NOTES:

1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE NOTED.
2. ⌀ DENOTES INTERNAL ADJUSTMENT.
3. 1 EXT CLOCK SHOWN FOR 10MHZ OPERATION. CIRCUIT MAY BE MODIFIED FOR OTHER EXT FREQ:
   .1 FOR 1MHZ OPERATION REMOVE U4 PACKAGE AND CONNECT A JUMPER FROM PIN 11 TO PIN 14.
   .2 FOR 5MHZ OPERATION CUT RUN FROM U4 PIN 1 TO U4 PIN 12 AND CUT RUN FROM U2 PIN 6 TO U4 PIN 14. CONNECT JUMPER FROM U2 PIN 6 TO U4 PIN 1.
4. 2 LINE SELECTOR SWITCH CONNECTIONS AND TRANSFORMER CENTER TAP OMITTED IN 100 V MODEL.
5. POWER SUPPLY AND GROUND CONNECTIONS:

U	+5 PIN	GND PIN
1	1	8
2,3,15,18,21,24,27,30,34	14	7
4,5,6,7,9,10,11,12	5	10
13,16,19,22,25,28,31	4	11
17,20,23,26,29,32	5	12
8	16	8

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.000 - 100 DIA ± .003 .002
.101 - 200 DIA ± .004 .002
.201 - 500 DIA ± .006 .003
.501 - 1.00 DIA ± .010 .005

DR. R. TKOBERG 8/1/73
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ENG
ENG
MATERIAL
FINISH

REV | CHANGE DESCRIPTION | DR | CHK | APPR

MODEL 1941A
DIGITAL FREQUENCY COUNTER

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SCALE | SHT 1 OF 2 | REV

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